Perspective Shadow Maps

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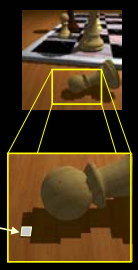
shadow maps

- Williams, Siggraph '78
  - render scene from light source
  - shadowing by depth comparison

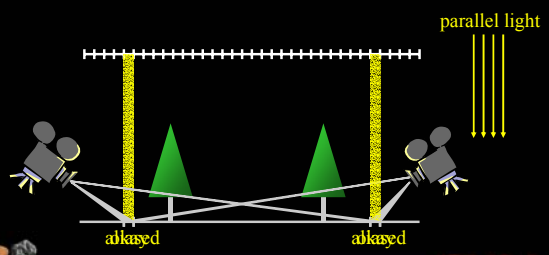
shadow map aliasing

- prone to aliasing when zooming into shadow boundaries



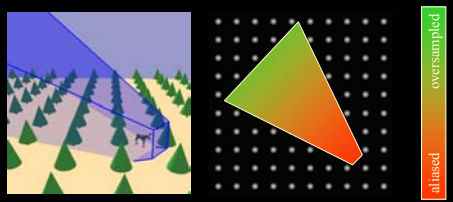
shadow map aliasing

- perspective aliasing



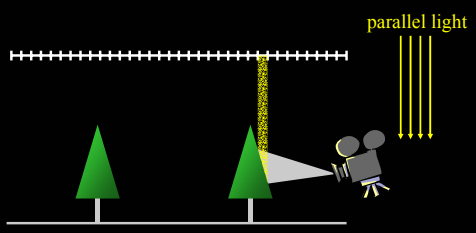
shadow map aliasing

- perspective aliasing
  - smooth transition



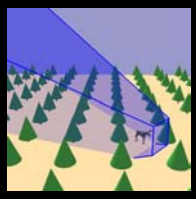
shadow map aliasing

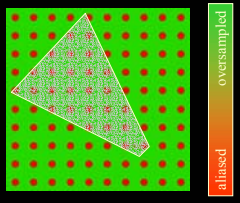
- projection aliasing



shadow map aliasing

- projection aliasing
  - very local

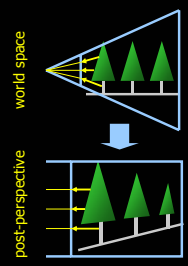


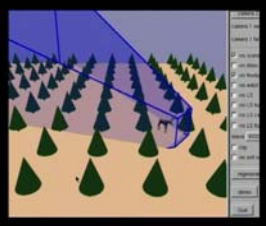


previous work

- Reeves et al., Siggraph '87:
  - "Percentage Closer Filtering"
- Tadamura et al., Visual Computer '01
  - "Plural Sunlight Depth Buffers"
- Fernando et al., Siggraph '01:
  - "Adaptive Shadow Maps"

perspective transformation

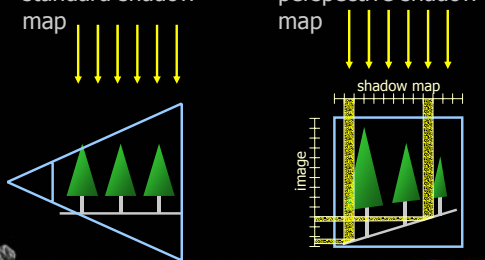




perspective shadow map

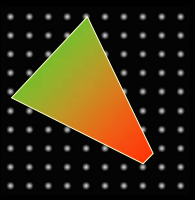
- standard shadow map

- perspective shadow map

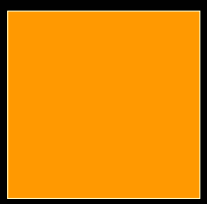


perspective shadow map

- standard shadow map



- perspective shadow map

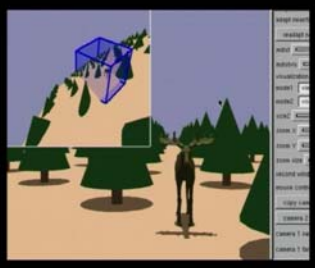


perspective shadow map

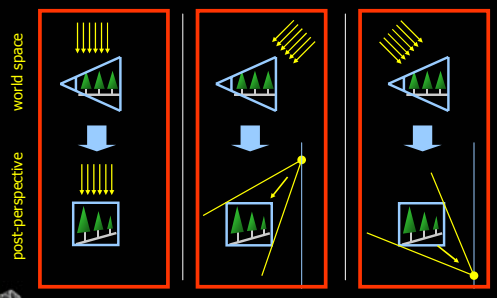
- shadow map in post-perspective space
- just another shadow map projection
- reduces perspective aliasing
- regeneration per frame necessary

light source transformation

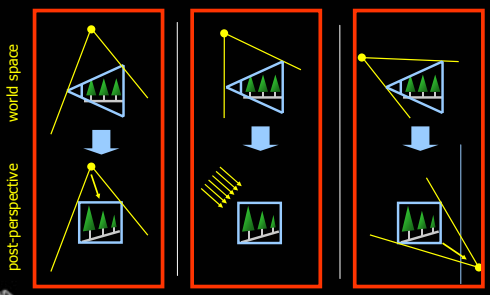
- parallel light becomes point light



parallel light transformation

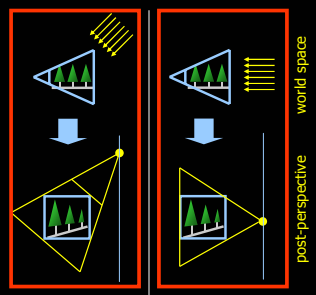


point light transformation



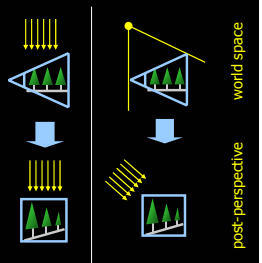
discussion

- bad case:
  - point light close to frustum
- worst case
  - becomes uniform shadow map



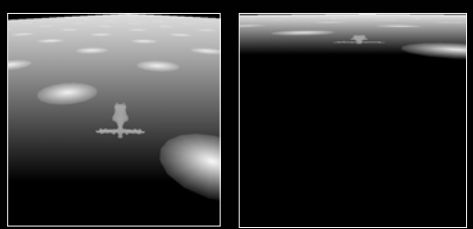
discussion

- best case:
  - parallel light in post-perspective space
  - no new perspective distortion



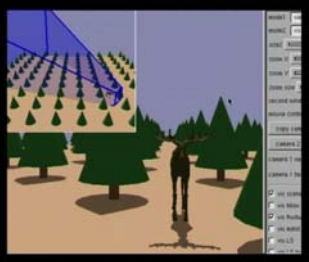
near plane selection

- near plane as far as possible



near plane selection

- automatic selection: reading back depth buffer

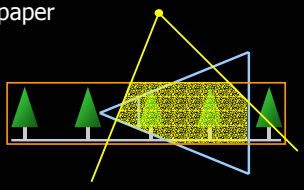


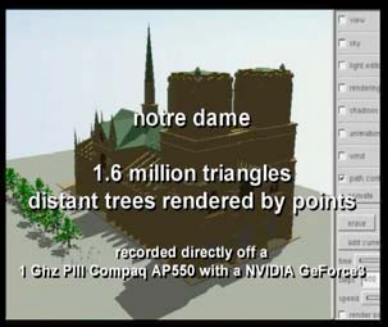
shadows from behind

- virtually move camera backwards

shadow map window

- geometric method to include all necessary objects
  - details in the paper





results

- first implementation on an Xbox game developer kit

courtesy of Thatcher Ulrich

conclusion

- perspective shadow maps
  - shadow map in post-perspective space
  - just another shadow map matrix
  - non-uniform shadow map resolution
  - needs recomputation per frame
  - minimal overhead for dynamic scenes

acknowledgements

- Marie Curie Post-Doctoral Fellowship of the European Union
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- Frédo Durand

thank you

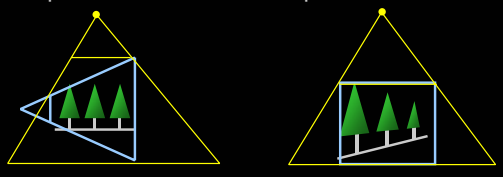
http://www-sop.inria.fr/reves

shadow maps

- Williams, Siggraph '78
  - render scene from light source
  - shadowing by depth comparison

idea

- uniform shadow map
- perspective shadow map



discussion

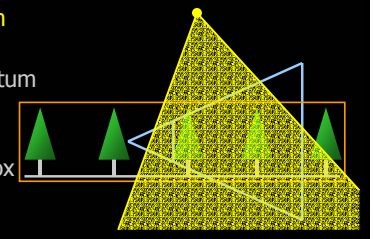
- ideal case
  - directional light parallel to image plane
  - miner's lamp
- worst case
  - parallel light from front or behind (becomes uniform shadow map)

additional issues

- shadow map window
- camera near/far selection
- shadows from the back

shadow map window

- shadow map must contain:
  - light frustum
  - cut off by camera frustum
  - clipped by scene's bounding box



shadow map window

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